

Abstracts of
4th IUFoST-Japan Webinar on Food Measurement and Characterization

Mar. 10th, 2023



IUFOST–Japan

4th IUFOST-Japan Webinar on Food Measurement and Characterization

Date: March 10th, 2023 (Fri) 13:00~15:25 (JST)

Organizer: IUFOST-Japan

Chair: Atsushi Hashimoto, Mito Kokawa

Cochair Yasuki Matsumura, Kentaro Matsumiya

Program

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| 13:00-13:05 | Opening remarks (Chair: Atsushi Hashimoto) |
| 13:05-13:35 | Shin Yee Wong (Singapore Institute of Technology, Singapore)
Near-infrared as a process analytical technology (PAT) for the milk powder blending process |
| 13:35-14:05 | Yoshito Saito (Niigata University, Japan,)
Non-destructive optical sensing of agricultural products for advanced precision agriculture |
| 14:05-14:10 | Break |
| 14:10-14:40 | Norhashila Hashim (Universiti Putra Malaysia, Malaysia)
Laser-induced backscattering imaging as a non-destructive method for quality evaluation of food and agricultural products |
| 14:40-15:10 | Mito Kokawa (University of Tsukuba, Japan)
Analysis of foods using spatially factorized spectroscopy |
| 15:10-15:20 | Discussion |
| 15:20-15:25 | Closing remarks (Vice President of IUFOST-Japan, Yasuki Matsumura) |

Near-Infrared as a process analytical technology (PAT) for the milk powder blending process

Food, Chemical and Biotechnology Cluster, Singapore Institute of Technology
Geordi Tristan, Kin Hong Tay, **Shin Yee Wong**

In industrial food processing, offline testing is normally carried out prior to batch release as part of the quality control process. Offline testing can take hours or days, leading to delays in product release. Inline PAT is an attractive alternative as data can be collected continuously, and results can be derived automatically in minutes or second. Inline analytical sensors provide fast, automatic, and continuous chemical or physical measurements in the form of electrical signals. Using the vast data collected from the online sensors, chemometrics can be used to analyze and extract relevant patterns and information. Spectroscopic sensors such as Ultraviolet-Visible spectroscopy (UV-Vis), Infrared (IR) spectroscopy, Raman spectroscopy, Fluorescence spectroscopy, etc. are often used as PAT to facilitate various research studies and experiments.

In this talk, the suitability and reliability of PAT in monitoring milk powder blending process will be discussed. The uniformity end point was predicted using Near-Infrared (NIR) probe, and subsequently validated using offline Fourier Transform Infrared Spectroscopy (FTIR). A standard milk formulation (SMF) made up of 50% lactose, 40% skim milk powder, and 10% whey protein concentrate was used. Additionally, the detection limit of the NIR probe was investigated using Vitamin C powder. The average predicted uniformity end point using the inline NIR fixed reference (63.89 ± 2.06 min), and dynamic reference conformity test (63.00 ± 5.25 min) were comparable with the offline FTIR measurement (56.6 ± 0.71 min). A three-component Partial Least Square Regression (PLSR) model was constructed and validated for Vitamin C. The detection limit is 0.11%, which is higher than the vitamin C level commonly found in most infant milk formula (0.035%).

Shin Yee, Wong obtained her PhD in food engineering from the University of Wisconsin-Madison. She has a strong interest in crystallization and process analytical technologies in food and pharmaceutical manufacturing. At the Singapore Institute of Technology, her research interest focuses on crystallization and process engineering, with a special interest for technology translation from academics to industrial applications.

Non-destructive optical sensing of agricultural products for advanced precision agriculture

Institute of Science and Technology, Niigata University
Yoshito Saito

As the trade-off problem between food production and environmental preservation becomes more serious due to a rapidly growing world population, "precision agriculture" is required to obtain maximum yield and quality with minimum environmental loads. To realize the precision agriculture, it is necessary to accurately measure the actual growing plants in fields, environment, and the quality of the crop after harvest with non-destructive techniques.

In recent years, near-infrared spectroscopy, fluorescence spectroscopy, and related imaging techniques have been used in the agricultural and food industries. These methods can measure the quality of agricultural and food products easily, quickly, and nondestructively, and are expected to be further implemented in many industries in the near future.

In this talk, some of our recent findings on optical measurement, mainly using fluorescence spectroscopy and light scattering, will be presented.

京都大学農学部卒業，京都大学大学院農学研究科を修了。その後，Web 関連企業にてシステムエンジニアリングに 3 年間従事した後，京都大学大学院農学研究科博士課程に進学。その間，日本学術振興会特別研究員（DC2）として研究に従事。2022 年 3 月，博士（農学）取得。現在，新潟大学自然科学系農学部助教。

The presenter graduated from the Faculty of Agriculture and Graduate School of Agriculture, Kyoto University. After working for 3 years as a system engineer in a web-related company, he entered the doctoral course of the Graduate School of Agriculture, Kyoto University, where he was engaged in research as a JSPS Research Fellow (DC2). He got a PhD in agriculture in March 2022. Currently, he is an Assistant Professor at the faculty of agriculture, institute of science and technology, Niigata University.

Laser-Induced Backscattering Imaging as A Non-Destructive Method for Quality Evaluation of Food and Agricultural Products

Department of Biological and Agricultural Engineering, Faculty of Engineering,
Universiti Putra Malaysia
SMART Farming Technology Research Centre (SFTRC), Faculty of Engineering,
Universiti Putra Malaysia

Norhashila Hashim

Almost half of all agricultural and food products are wasted globally due to inefficient postharvest handling. Baseline projections indicated that the total global consumption of fruits and vegetables will nearly double from 2010 to 2050. However, the average per capita availability will only increase by 40%. Thus, reducing losses is one of the leading global strategies for achieving sustainable food security. While increasing cultivation areas seems unrealistic, it is sensible to aim at increasing production yield by improving the current postharvest handling. This paper presents an overview of laser-induced backscattering imaging (LLBI) for rapid and non-destructive quality evaluation of agricultural products. The principles and concept of LLBI techniques are highlighted and the mechanism applied is discussed. The case studies of the application of LLBI techniques are also presented. LLBI offers promising solution and innovation with sophisticated technology that promotes efficient and better productivity in agricultural and food industries. It promotes automation elements in the productivity, in line with industrial revolutions 4.0 that leads to an improvement in the production chain and indirectly increasing production efficiency.

Ir. Dr. Norhashila Hashim is currently an associate professor and the Head of Department at the Department of Biological and Agricultural Engineering, Faculty of Engineering, Universiti Putra Malaysia (UPM). Throughout her career, she has significantly contributed to the development of curriculum and scientific research with outstanding achievements. Until now, she has authored more than 100 scientific publications including high impact factor journals, proceeding papers, book chapters, etc. Her publications reflect her research interest in postharvest engineering, agricultural process engineering and precision agriculture.

Analysis of foods using spatially factorized spectroscopy

Faculty of Life and Environmental Sciences, University of Tsukuba

Mito Kokawa

Non-destructive analysis methods for evaluating food products have been widely studied due to their many advantages such as speed, easy implementation, and the possibility of total inspection. With increasing concern on environmental pollution, these methods are gaining increased attention because they do not require organic solvents or chemical reagents.

However, one of the most challenging aspects of non-destructive analyses is that there is no step to separate the target compound with the food matrix. This is in contrast with chromatography-based methods where the separation step is critical in obtaining reliable results. As a result, the signals obtained in non-destructive analyses are “mixed”, with the consequences that the signals from the food matrix may interfere with the quantification of the analyte in interest. In practice, this problem is observed when the calibration dataset (the dataset used to calculate the prediction model) is different from the test dataset (the dataset used to apply the model to).

Here, we introduce a novel method for analyzing the chemical components of foods, namely, Spatially Factorized Spectroscopy (SFS). This method uses the spatial information acquired by hyperspectral micro-imaging to separate mixed spectra into their pure spectra and concentrations. We show that the acquisition of Raman spectra at microscopic points enables the separation of different chemical components in a mixed sample. This spectra separation can serve as preprocessing step before quantification of the target analyte.

In this presentation, two sets of simple model samples: oil in water (O/W) emulsions with different salt concentrations and mixtures of sugars were prepared. The analytes to be quantified were salt and glucose for the two sets of samples, respectively. Raman spectra were acquired at multiple microscopic points on the mixed sample and spectral unmixing algorithms such as Multivariate Curve Resolution - Alternative Least Squares (MCR-ALS) and Non-negative Matrix Factorization (NMF) were applied to unmix the spectra. For quantification, the multiple measurements on one sample were averaged to represent its chemical composition.

The quantification results showed that SFS was effective in cases where the calibration and test set differed greatly in terms of composition. For example, in the case of O/W emulsions, salt concentrations were estimated with high accuracy even when the ratio of oil to water was different between the calibration and test data sets. These results suggest that the use of spatial information to separate spectra may lead to estimation models that are more robust.

Mito Kokawa obtained her PhD in agriculture from the University of Tokyo in 2014. After working as a visiting researcher at KU Leuven, Belgium and as a JSPS postdoctoral researcher at the National Agriculture and Food Research Organization (NARO), Japan, she was appointed as assistant professor at the University of Tsukuba. Her research interests are in non-destructive food evaluation and food processing.

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